Examples

MathML in ConTEXt

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PRAGMA ADE

Content

Derivatives

Integrals

Series

Logs

Goniometrics

Statistics

Matrices

Colofon

This document shows a few formulas coded in MATHML and typeset by CONTEXT. The examples are taken from an old copy of 'Handbook of Chemistry and Physics' as well as 'Wiskunde voor het HBO (R. van Asselt et al.)'. We assume no responsibility for the coding being 100% all correct.

These examples are typeset using the default settings. There are several ways to influence the look and feel of a formula. Details on how to process MATHML can be found in the XML related documentation that comes with CONTEXT.

You can get more information on CONTEXT at our website, in TEX usergroup publications and in (the archives of) the CONTEXT mailing list.

Hans Hagen
Hasselt, Januari 2001
www.pragma-ade.com

preliminary version

Derivatives

pc-d-001
pc-d-002
pc-d-003
pc-d-004
pc-d-005
pc-d-006
pc-d-007
pc-d-008
pc-d-009
pc-d-010
pc-d-011
pc-d-043

$$\frac{\mathrm{d}a}{\mathrm{d}x} = 0$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> a </ci>
    </apply>
    <ci> 0 </ci>
  </apply>
</math>
```

$$\frac{\mathrm{d}x}{\mathrm{d}x} = 1$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> x </ci>
    </apply>
    <cn> 1 </cn>
  </apply>
</math>
```

$$\frac{\mathrm{d}(au)}{\mathrm{d}x} = a\,\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <times/>
        <ci> a </ci>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <ci> a </ci>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}(u+v-w)}{\mathrm{d}x} = \frac{\mathrm{d}u}{\mathrm{d}x} + \frac{\mathrm{d}v}{\mathrm{d}x} + \frac{\mathrm{d}w}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <plus/>
        <ci> u </ci>
        <ci> v </ci>
        <apply> <minus/>
          <ci> w </ci>
        </apply>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> v </ci>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> w </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}(uv)}{\mathrm{d}x} = u\frac{\mathrm{d}u}{\mathrm{d}x} + v\frac{\mathrm{d}v}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <times/>
        <ci> u </ci>
        <ci> v </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <ci> u </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci>
          </bvar> <ci> u </ci>
        </apply>
      </apply>
      <apply> <times/>
        <ci> v </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci>
          </bvar> <ci> v </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}(uvw)}{\mathrm{d}x} = uv\frac{\mathrm{d}w}{\mathrm{d}x} + vw\frac{\mathrm{d}u}{\mathrm{d}x} + uw\frac{\mathrm{d}v}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <times/>
        <ci> u </ci>
        <ci> v </ci>
        <ci> w </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <ci> u </ci>
         <ci> v </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> w </ci>
        </apply>
      </apply>
      <apply> <times/>
        <ci> v </ci>
        <ci> w </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> u </ci>
        </apply>
      </apply>
      <apply> <times/>
        <ci> u </ci>
        <ci> w </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> v </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}\left(\frac{u}{v}\right)}{\mathrm{d}x} = \frac{v\,\frac{\mathrm{d}u}{\mathrm{d}x} - u\,\frac{\mathrm{d}v}{\mathrm{d}x}}{v^2} = \frac{1}{v}\,\frac{\mathrm{d}u}{\mathrm{d}x} - \frac{1}{u}\,\frac{\mathrm{d}v}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <ci> u </ci>
        <ci> v </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <minus/>
        <apply> <times/>
          <ci> v </ci>
          <apply> <diff/>
            <bvar> <ci> x </ci> </bvar>
            <ci> u </ci>
          </apply>
        </apply>
        <apply> <times/>
          <ci> u </ci>
          <apply> <diff/>
            <bvar> <ci> x </ci> </bvar>
            <ci> v </ci>
          </apply>
        </apply>
      </apply>
      <apply> <power/>
        <ci> v </ci>
        <cn> 2 </cn>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <ci> v </ci>
        </apply>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> u </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <ci> u </ci>
        </apply>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> v </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}(u^n)}{\mathrm{d}x} = n\,u^{n-1}\,\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <power/>
        <ci> u </ci>
        <ci> n </ci>
      </apply>
    </apply>
    <apply> <times/>
      <ci> n </ci>
      <apply> <power/>
        <ci> u </ci>
        <apply> <minus/>
          <ci> n </ci>
          <cn> 1 </cn>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}(\sqrt{u})}{\mathrm{d}x} = \frac{1}{2\sqrt{u}}\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <root/>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <times/>
          <cn> 2 </cn>
          <apply> <root/>
            <ci> u </ci>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}\left(\frac{1}{u}\right)}{\mathrm{d}x} = \left(-\frac{1}{u^2}\right)\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <power/>
            <ci> u </ci>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}\,\frac{1}{u^n}}{\mathrm{d}x} = \left(-\frac{n}{u^{n+1}}\right)\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <ci> u </ci>
          <cn> n </cn>
        </apply>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <minus/>
        <apply> <divide/>
          <ci> n </ci>
          <apply> <power/>
            <ci> u </ci>
            <apply> <plus/>
              <ci> n </ci>
              <cn> 1 </cn>
            </apply>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{\mathrm{d}\,(\sinh u)^{-1}}{\mathrm{d}x} = \frac{\mathrm{d}\log\left(u+\sqrt{u^2+1}\right)}{\mathrm{d}x} = \frac{1}{\sqrt{u^2+1}}\frac{\mathrm{d}u}{\mathrm{d}x}$$

```
<math>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <inverse/>
        <apply> <sinh/>
          <ci> u </ci>
        </apply>
      </apply>
    </apply>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <log/>
        <apply> <plus/>
          <ci> u </ci>
          <apply> <root/>
            <apply> <plus/>
              <apply> <power/>
                <ci> u </ci>
                <cn> 2 </cn>
              </apply>
              <cn> 1 </cn>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <root/>
          <apply> <plus/>
            <apply> <power/>
              <ci> u </ci>
              <cn> 2 </cn>
            </apply>
            <cn> 1 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

Integrals

pc-i-022 pc-i-061 pc-i-380

$$\int \frac{1}{x\sqrt{a^2 \pm x^2}}\,\mathrm{d}x = -\frac{1}{a}\log\left(\frac{a+\sqrt{a^2 \pm x^2}}{x}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <int/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <times/>
          <ci> x </ci>
          <apply> <root/>
            <apply> <fn> <ci> &plusminus; </ci> </fn>
              <apply> <power/>
                <ci> a </ci>
                <cn> 2 </cn>
              </apply>
              <apply> <power/>
                <ci> x </ci>
                <cn> 2 </cn>
              </apply>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn> <ci> a </ci>
        </apply>
        <apply> <log/>
          <apply> <divide/>
            <apply> <plus/>
              <ci> a </ci>
              <apply> <root/>
                <apply> <fn> <ci> &plusminus; </ci> </fn>
                  <apply> <power/>
                    <ci> a </ci>
                    <cn> 2 </cn>
                  </apply>
                  <apply> <power/>
                    <ci> x </ci>
                    <cn> 2 </cn>
                  </apply>
                </apply>
              </apply>
            </apply>
            <ci> x </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\int \frac{1}{a+b\,x^2}\,\mathrm{d}x = \frac{1}{2\sqrt{-ab}}\log\left(\frac{a+x\sqrt{-ab}}{a-x\sqrt{-ab}}\right) \vee \frac{1}{\sqrt{-ab}}\tanh^{-1}\left(\frac{x\sqrt{-ab}}{a}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <int/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <plus/>
          <ci> a </ci>
          <apply> <times/>
            <ci> b </ci>
            <apply> <power/>
              <ci> x </ci>
              <cn> 2 </cn>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <or/>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <times/>
            <cn> 2 </cn>
            <apply> <root/>
              <apply> <minus/>
                <apply> <times/>
                  <ci> a </ci>
                  <ci> b </ci>
                </apply>
              </apply>
            </apply>
          </apply>
        </apply>
        <apply> <log/>
          <apply> <divide/>
            <apply> <plus/>
              <ci> a </ci>
              <apply> <times/>
                <ci> x </ci>
                <apply> <root/>
                  <apply> <minus/>
                    <apply> <times/>
                      <ci> a </ci>
                      <ci> b </ci>
                    </apply>
                  </apply>
                </apply>
              </apply>
            </apply>
            <apply> <minus/>
              <ci> a </ci>
              <apply> <times/>
                <ci> x </ci>
                <apply> <root/>
                  <apply> <minus/>
                    <apply> <times/>
                      <ci> a </ci>
                      <ci> b </ci>
                    </apply>
                  </apply>
                </apply>
              </apply>
            </apply>
          </apply>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
```

```
          <apply> <root/>
            <apply> <minus/>
              <apply> <times/>
                <ci> a </ci>
                <ci> b </ci>
              </apply>
            </apply>
          </apply>
        </apply>
        <apply> <power/>
          <apply> <tanh/>
            <apply> <divide/>
              <apply> <times/>
                <ci> x </ci>
                <apply> <root/>
                  <apply> <minus/>
                    <apply> <times/>
                      <ci> a </ci>
                      <ci> b </ci>
                    </apply>
                  </apply>
                </apply>
              </apply>
              <ci> a </ci>
            </apply>
          </apply>
          <apply> <minus/>
            <cn> 1 </cn>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\int \frac{1}{\cos(ax)\,1 \pm \sin(ax)}\,\mathrm{d}x = \mp\frac{1}{2a\,1 \pm \sin(ax)} + \frac{1}{2a}\log\tan\left(\frac{\pi}{4} + \frac{ax}{2}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <int/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <times/>
          <apply> <cos/>
            <apply> <times/>
              <ci> a </ci>
              <ci> x </ci>
            </apply>
          </apply>
          <apply> <fn> <ci> &plusminus; </ci> </fn>
            <cn> 1 </cn>
            <apply> <sin/>
              <apply> <times/>
                <ci> a </ci>
                <ci> x </ci>
              </apply>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <fn> <ci> &minusplus; </ci> </fn>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> a </ci>
            <apply> <fn> <ci> &plusminus; </ci> </fn>
              <cn> 1 </cn>
              <apply> <sin/>
                <apply> <times/>
                  <ci> a </ci>
                  <ci> x </ci>
                </apply>
              </apply>
            </apply>
          </apply>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> a </ci>
          </apply>
        </apply>
        <apply> <log/>
          <apply> <tan/>
            <apply> <plus/>
              <apply> <divide/>
                <ci> &pi; </ci>
                <cn> 4 </cn>
              </apply>
              <apply> <divide/>
                <apply> <times/>
                  <ci> a </ci>
                  <ci> x </ci>
                </apply>
                <cn> 2 </cn>
              </apply>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

```
    </apply>
  </apply>
</math>
```

Series

pc-s-001 pc-s-002 pc-s-003 wh-s-001 wh-s-002

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots = \frac{\pi}{4}$$

```
<math>
  <apply> <eq/>
    <apply> <plus/>
      <cn> 1 </cn>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <cn> 3 </cn>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <cn> 5 </cn>
      </apply>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <cn> 7 </cn>
        </apply>
      </apply>
      <ci> &cdots; </ci>
    </apply>
    <apply> <divide/>
      <ci> &pi; </ci>
      <cn> 4 </cn>
    </apply>
 </apply>
</math>
```

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \cdots = \frac{\pi^2}{6}$$

```
<math>
  <apply> <eq/>
    <apply> <plus/>
      <cn> 1 </cn>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 2 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 3 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 4 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <ci> &cdots; </ci>
    </apply>
    <apply> <divide/>
      <apply> <power/>
        <ci> &pi; </ci>
        <cn> 2 </cn>
      </apply>
      <cn> 6 </cn>
    </apply>
  </apply>
</math>
```

$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots = \frac{\pi^2}{12}$$

```
<math>
  <apply> <eq/>
    <apply> <plus/>
      <cn> 1 </cn>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <power/>
            <cn> 2 </cn>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 3 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <power/>
            <cn> 4 </cn>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <ci> &cdots; </ci>
    </apply>
    <apply> <divide/>
      <apply> <power/>
        <ci> &pi; </ci>
        <cn> 2 </cn>
      </apply>
      <cn> 12 </cn>
    </apply>
  </apply>
</math>
```

$$\forall\, x \in \mathrm{R} \;\Big|\; e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots + \frac{x^n}{n!} + \cdots$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <in/>
        <ci> x </ci>
        <ci> &reals; </ci>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> &exponentiale; </ci>
        <ci> x </ci>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <ci> x </ci>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 2 </cn>
          </apply>
          <apply> <factorial/>
            <cn> 2 </cn>
          </apply>
        </apply>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 3 </cn>
          </apply>
          <apply> <factorial/>
            <cn> 3 </cn>
          </apply>
        </apply>
        <ci> &cdots; </ci>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <ci> n </ci>
          </apply>
          <apply> <factorial/>
            <ci> n </ci>
          </apply>
        </apply>
        <ci> &cdots; </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall\ x \in \mathrm{R}\ \left|\ \mathrm{e}^{-x} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \cdots + (-1)^n \frac{x^n}{n!} \cdots\right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <in/>
        <ci> x </ci>
        <ci> &reals; </ci>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> &exponentiale; </ci>
        <apply> <minus/>
          <ci> x </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <apply> <minus/>
          <ci> x </ci>
        </apply>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 2 </cn>
          </apply>
          <apply> <factorial/>
            <cn> 2 </cn>
          </apply>
        </apply>
        <apply> <minus/>
          <apply> <divide/>
            <apply> <power/>
              <ci> x </ci>
              <cn> 3 </cn>
            </apply>
            <apply> <factorial/>
              <cn> 3 </cn>
            </apply>
          </apply>
          <ci> &cdots; </ci>
          <apply> <times/>
            <apply> <power/>
              <apply> <minus/>
                <cn> 1 </cn>
              </apply>
              <ci> n </ci>
            </apply>
            <apply> <divide/>
              <apply> <power/>
                <ci> x </ci>
                <ci> n </ci>
              </apply>
              <apply> <factorial/>
                <ci> n </ci>
              </apply>
            </apply>
            <ci> &cdots; </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

Logs

wh-l-001 wh-l-002 wh-l-003 wh-l-004

$$\forall\ a > 0 \wedge b > 0 \left| \log_g (ab) = \log_g a + \log_g b \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
        <apply> <gt/>
          <ci> b </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <apply> <times/>
          <ci> a </ci>
          <ci> b </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> b </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall\ a > 0 \wedge b > 0 \left| \log_g \left(\frac{a}{b} \right) = \log_g a - \log_g b \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
        <apply> <gt/>
          <ci> b </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <apply> <divide/>
          <ci> a </ci>
          <ci> b </ci>
        </apply>
      </apply>
      <apply> <minus/>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> b </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall\ b \in \mathrm{R} \wedge a > 0 \left| \log_g^b a = b \log_g a \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <in/>
          <ci> b </ci>
          <ci> &reals; </ci>
        </apply>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
        <ci> b </ci>
      </apply>
      <apply> <times/>
        <ci> b </ci>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall\ a > 0 \left| \log_g a = \frac{\log_p a}{\log_p g} \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <ci> a </ci>
      </apply>
      <apply> <divide/>
        <apply> <log/>
          <logbase> <ci> p </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> p </ci> </logbase>
          <ci> g </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

Goniometrics

wh-g-001
wh-g-002
wh-g-003
wh-g-004
wh-g-005
wh-g-006
wh-g-007
wh-g-008
wh-g-009
wh-g-010
wh-g-011
wh-g-012
wh-g-013
wh-g-014
wh-g-015
wh-g-016

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

```
<math>
  <apply> <eq/>
    <apply> <sin/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\sin(x - y) = \sin x \cos y - \cos x \sin y$$

```
<math>
  <apply> <eq/>
    <apply> <sin/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\cos(x+y) = \cos x \cos y - \sin x \sin y$$

```
<math>
  <apply> <eq/>
    <apply> <cos/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\cos(x - y) = \cos x \cos y + \sin x \sin y$$

```
<math>
  <apply> <eq/>
    <apply> <cos/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\tan(x+y) = \frac{\tan x + \tan y}{1 - \tan x \tan y}$$

```
<math>
  <apply> <eq/>
    <apply> <tan/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <plus/>
        <apply> <tan/>
          <ci> x </ci>
        </apply>
        <apply> <tan/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <minus/>
        <cn> 1 </cn>
        <apply> <times/>
          <apply> <tan/>
            <ci> x </ci>
          </apply>
          <apply> <tan/>
            <ci> y </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\tan(x - y) = \frac{\tan x - \tan y}{1 + \tan x \tan y}$$

```
<math>
  <apply> <eq/>
    <apply> <tan/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <minus/>
        <apply> <tan/>
          <ci> x </ci>
        </apply>
        <apply> <tan/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <apply> <times/>
          <apply> <tan/>
            <ci> x </ci>
          </apply>
          <apply> <tan/>
            <ci> y </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\sin p + \sin q = 2 \sin\left(\frac{p+q}{2}\right) \cos\left(\frac{p-q}{2}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <plus/>
      <apply> <sin/>
        <ci> p </ci>
      </apply>
      <apply> <sin/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <sin/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\sin p - \sin q = 2\cos\left(\frac{p+q}{2}\right)\sin\left(\frac{p-q}{2}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <sin/>
        <ci> p </ci>
      </apply>
      <apply> <sin/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\cos p + \cos q = 2\cos\left(\frac{p+q}{2}\right)\cos\left(\frac{p-q}{2}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <plus/>
      <apply> <cos/>
        <ci> p </ci>
      </apply>
      <apply> <cos/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\cos p - \cos q = -2 \sin\left(\frac{p+q}{2}\right) \sin\left(\frac{p-q}{2}\right)$$

```
<math>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <cos/>
        <ci> p </ci>
      </apply>
      <apply> <cos/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <cn> 2 </cn>
        <apply> <sin/>
          <apply> <divide/>
             <apply> <plus/>
              <ci> p </ci>
              <ci> q </ci>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
        <apply> <sin/>
          <apply> <divide/>
            <apply> <minus/>
              <ci> p </ci>
              <ci> q </ci>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$2 \sin \alpha \cos \beta = \sin (\alpha + \beta) + \sin (\alpha - \beta)$$

```
<math>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <sin/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <cos/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$2\cos\alpha\sin\beta = \sin(\alpha+\beta) - \sin(\alpha-\beta)$$

```
<math>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <sin/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$2\cos\alpha\cos\beta = \cos(\alpha+\beta) + \cos(\alpha-\beta)$$

```
<math>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <cos/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <cos/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$-2\sin\alpha\cos\beta = \sin(\alpha+\beta) - \sin(\alpha-\beta)$$

```
<math>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <times/>
        <cn> 2 </cn>
        <apply> <sin/>
          <ci> &alpha; </ci>
        </apply>
        <apply> <cos/>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall \triangle ABC \left| \frac{a}{\sin \alpha} = \frac{a}{\sin \beta} = \frac{a}{\sin \gamma} \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &triangle; </mi>
        <mi> A </mi>
        <mi> B </mi>
        <mi> C </mi>
      </mrow>
    </condition>
    <apply> <eq/>
      <apply> <divide/>
        <ci> a </ci>
        <apply> <sin/>
          <ci> &alpha; </ci>
        </apply>
      </apply>
      <apply> <divide/>
        <ci> a </ci>
        <apply> <sin/>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <divide/>
        <ci> a </ci>
        <apply> <sin/>
          <ci> &gamma; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\forall \triangle ABC \left| \begin{array}{l} a^2 = b^2 + c^2 - 2bc\cos\alpha \\ b^2 = a^2 + c^2 - 2ac\cos\beta \\ c^2 = a^2 + b^2 - 2ab\cos\gamma \end{array} \right.$$

```
<math>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &triangle; </mi>
        <mi> A </mi>
        <mi> B </mi>
        <mi> C </mi>
      </mrow>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> a </ci>
        <cn> 2 </cn>
      </apply>
      <apply> <plus/>
        <apply> <power/>
          <ci> b </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <power/>
          <ci> c </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <minus/>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> b </ci>
            <ci> c </ci>
            <apply> <cos/>
              <ci> &alpha; </ci>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <eq/>
      <apply> <power/>
        <ci> b </ci>
        <cn> 2 </cn>
      </apply>
      <apply> <plus/>
        <apply> <power/>
          <ci> a </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <power/>
          <ci> c </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <minus/>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> a </ci>
            <ci> c </ci>
            <apply> <cos/>
              <ci> &beta; </ci>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <eq/>
      <apply> <power/>
        <ci> c </ci>
        <cn> 2 </cn>
      </apply>
```

```
      <apply> <plus/>
        <apply> <power/>
          <ci> a </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <power/>
          <ci> b </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <minus/>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> a </ci>
            <ci> b </ci>
            <apply> <cos/>
              <ci> &gamma; </ci>
            </apply>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

Statistics

wh-o-001 wh-o-002 wh-o-003

$$\overline{x} = \frac{1}{n} \sum x_i$$

```
<math>
  <apply> <eq/>
    <apply> <mean/>
      <ci> x </ci>
    </apply>
    <apply> <times/>
      <apply> <divide/>
        <cn> 1 </cn>
        <ci> n </ci>
      </apply>
      <apply> <sum/>
        <ci> <msub> <mi> x </mi> <mi> i </mi> </msub> </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\sigma(x) \approx \sqrt{\frac{\sum (x_i - \overline{x})^2}{n-1}}$$

```
<math>
  <apply> <approx/>
    <apply> <sdev/>
      <ci> x </ci>
    </apply>
    <apply> <root/>
      <apply> <divide/>
        <apply> <sum/>
          <apply> <power/>
            <apply> <minus/>
              <ci> <msub> <mi> x </mi> <mi> i </mi> </msub> </ci>
              <apply> <mean/>
                <ci> x </ci>
              </apply>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
        <apply> <minus/>
          <ci> n </ci>
          <cn> 1 </cn>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\sigma(x)^2 \approx \overline{(x_i - \overline{x})^2} = \frac{1}{n-1} \sum (x_i - \overline{x})^2$$

```
<math>
  <apply> <approx/>
    <apply> <variance/>
      <ci> x </ci>
    </apply>
    <apply> <eq/>
      <apply> <mean/>
        <apply> <power/>
          <apply> <minus/>
            <ci> <msub> <mi> x </mi> <mi> i </mi> </msub> </ci>
            <apply> <mean/>
              <ci> x </ci>
            </apply>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <minus/>
            <ci> n </ci>
            <cn> 1 </cn>
          </apply>
        </apply>
        <apply> <sum/>
          <apply> <power/>
            <apply> <minus/>
              <ci> <msub> <mi> x </mi> <mi> i </mi> </msub> </ci>
              <apply> <mean/>
                <ci> x </ci>
              </apply>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

Matrices

wh-m-001 wh-m-002

$$\begin{vmatrix} \sin\alpha & \cos\alpha \\ \sin\beta & \cos\beta \end{vmatrix} = \sin(\alpha - \beta)$$

```
<math>
  <apply> <eq/>
    <apply> <determinant/>
      <matrix>
        <matrixrow>
          <apply> <sin/> <ci> &alpha; </ci> </apply>
          <apply> <cos/> <ci> &alpha; </ci> </apply>
        </matrixrow>
        <matrixrow>
          <apply> <sin/> <ci> &beta; </ci> </apply>
          <apply> <cos/> <ci> &beta; </ci> </apply>
        </matrixrow>
      </matrix>
    </apply>
    <apply> <sin/>
      <apply> <minus/>
        <ci> &alpha; </ci>
        <ci> &beta; </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$|I| = \begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} = 1$$

```
<math>
  <apply> <eq/>
    <apply> <determinant/>
     <ci> I </ci>
    </apply>
    <apply> <determinant/>
      <matrix>
        <matrixrow> <cn> 1 </cn> <cn> 0 </cn> </matrixrow>
        <matrixrow> <cn> 0 </cn> <cn> 1 </cn> </matrixrow>
      </matrix>
    </apply>
    <cn> 1 </cn>
  </apply>
</math>
```

Derivatives

$$\frac{\mathrm{d}a}{\mathrm{d}x} = 0$$

Integrals

$$\int \frac{1}{x\sqrt{a^2 \pm x^2}}\,\mathrm{d}x = -\frac{1}{a}\log\left(\frac{a+\sqrt{a^2 \pm x^2}}{x}\right)$$

Series

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots = \frac{\pi}{4}$$

Logs

$$\forall\ a > 0 \wedge b > 0 \left| \log_g(ab) = \log_g a + \log_g b \right.$$

Goniometrics

$$\sin(x+y) = \sin x \cos y + \cos x \sin y$$

Statistics

$$\overline{x} = \frac{1}{n} \sum x_i$$

Matrices

$$\begin{vmatrix} \sin\alpha & \cos\alpha \\ \sin\beta & \cos\beta \end{vmatrix} = \sin(\alpha - \beta)$$